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BitStream-The Rescue Messenger

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Abstract -- *In the last decade, there is an increase in natural disasters observed. In such situations, social media become an important resource to warn and get informed about disaster situations. Communication breakdown between emergency responders & trapped people causes difficulties in the evacuation process. So, Communication is important to find help in disasters. Apart from other solutions to the problem present in the market none of them is as energy-efficient this paper proposes a solution that uses a LoRa. It will be user-friendly and does not require any license to access it. With BitStream, users can send a customized message with GPS location over the LoRA network. Also, it is integrated into mobile devices to improve functionality.*

Keywords – *Long Range communication, Integrated Circuit, RSSI Received Signal Strength*

I. INTRODUCTION

In the case of natural disasters, Communication failure may occur in most extreme event scenarios which provoke loss of lives and properties. Also, the damage to CS alongside the rise in traffic crossing the network disrupts relief operations. Thus, rescuers aren't ready to exchange information and other people cannot communicate their position or invite assistance, and therefore the entire relief operation is hardly managed. Besides physical damage, the remaining CSS is insufficient to handle the increased got to make calls because the network becomes overloaded by a large number of communication attempts. Despite massive technological changes in recent years, communication problems persist including system failure, system overload, and incompatibility between communication systems employed by different agencies. a number of the precise technical problems identified in recent case studies are:

o Failure of the wired telephone system, due to explosion, etc. (experienced by police, fire-fighters, and military in the Toulouse ammonium nitrate disaster, September 2001)

o Overload of the telephone system due to insufficient lines (experienced during the Weybourne leaking container ship incident, Norfolk, May 1991)

o Saturation of the mobile phone network (Toulouse, 2001)

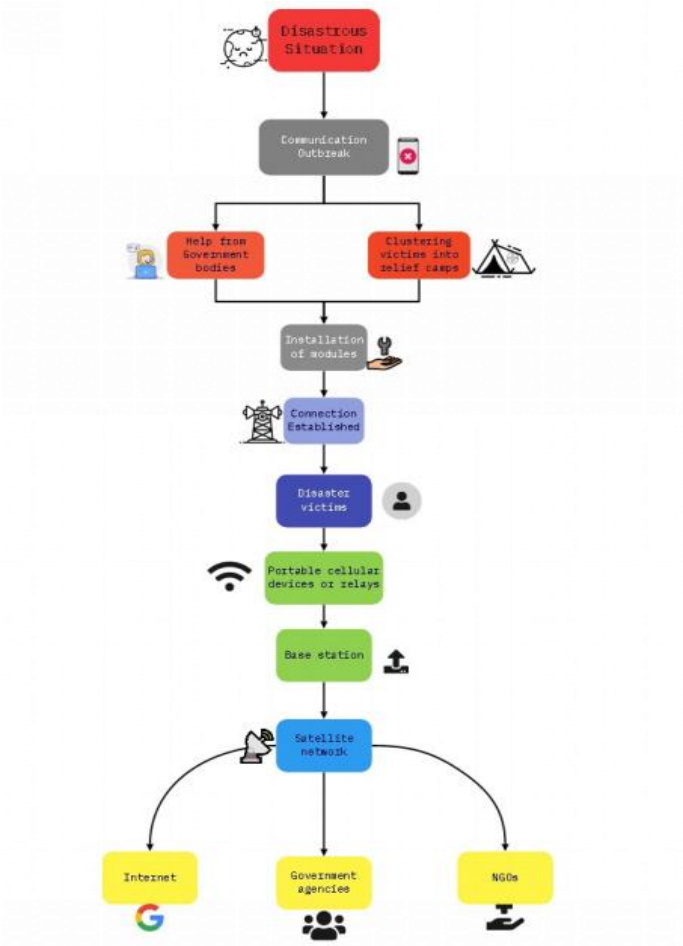
o Out-of-range radio communications (experienced by police during the Nypro (UK) Ltd. Chemical factory explosion, Glenborough, June 1974)

o Incompatible radio systems, such as lack of common communication frequencies experienced by fire, police, and coastguard during the Weybourne (Norfolk) leaking container ship incident, May 1991[7]

Text messaging and social networking have played a surprisingly important role in recent disasters and political upheavals. Lives were saved during Hurricane Katrina and the Haitian Earthquake because text messages were able to get through when phone calls could not. SMS text messages get through for one reason – they are very small pieces of information, and it takes far fewer resources for cellular carriers to transmit these messages compared to full phone calls. It is important to recognize text messaging and social media like Twitter as a potential option when nothing else works. [6]

It is important to highlight the high demand that exists during disaster events for several types of communications services available, and for keeping fast access and effective update of the information. In the same way, standardized communications and information processes have increased the reliability of communications traffic, besides easy access to the communications services through fast and reliable system integration and interoperability, to keep the communications flow in operation in all disaster events stages.[9]

II. FLOWCHART



When a communication failure happens in a disaster situation or an emergency people are not able to ask for help so this makes rescue operations hard as communication infrastructure is collapsed establishing communication quickly become difficult so some alternative solution to communicate instantly is needed which does not need too many infrastructures so normal people can use it easily and cheap that's why we planned to find

such a solution which can be used at such emergencies and can help normal people to communicate and ask for help easily till the time other communication media such as cellular communication or INTERNET becomes active again. [5]

III. DESIGN METHODOLOGY

Hardware Description:

Product architectures include the following components:

- LoRa Modules: These are used to communicate to other LoRa devices for this project we will be specifically using the LoRa 868MHZ SX1276 RF trans-receiver module.
- GPS Module: this module is to capture GPS data from satellite and send it to the microcontroller to further use.
- UI devices/Mobile: This device will have our mobile app installed on it so it can send a customized message with users' locations to any other user in the network and you can also keep track of all old messages and chats and at the receiver end it can help transmitter to locate on a map.
- Battery: it will be the main power supply for our device and will also help to charge our mobile device as it will be useful in such conditions.

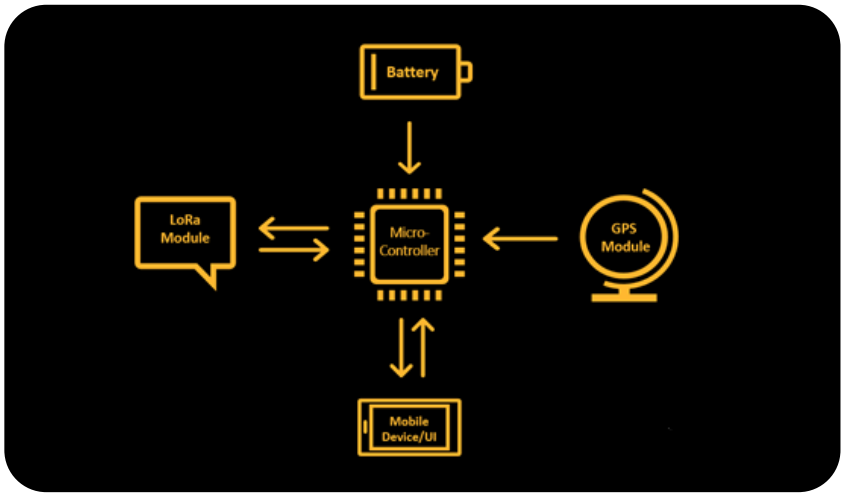


Fig. 01: Hardware Architecture of Bitstream

Program Flow:

First A customized message from a mobile or a prebuilt message in the device through serial is taken from the user by serial and then it will be capsulated and transferred to the LoRa module then LoRa Module Transmits this message using Antenna. At the receiver the captured packet is decapsulated and sent to Microcontroller through SPI Communication then the microcontroller sends that message to the device using Serial Communication.

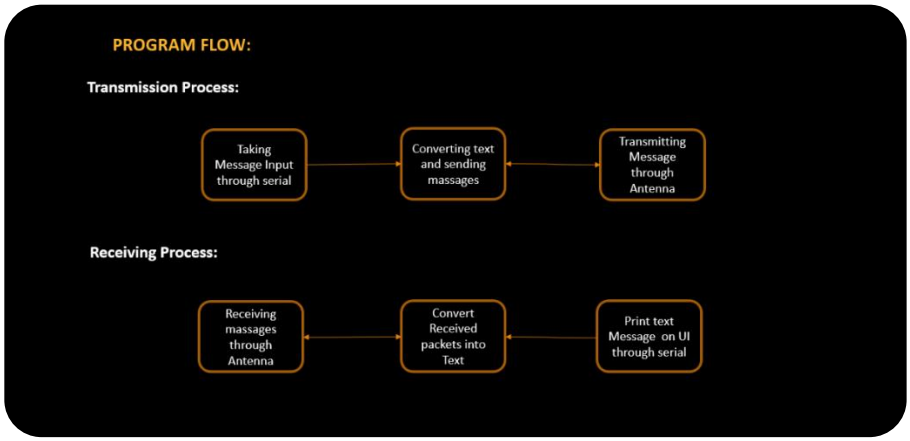


Fig. 02: Process flow of Bitstream

Why we prefer LoRa communication:
Due to wide-area coverage and low power consumption o the LoRa network, various applications provided by LoRa have been emerging in the IoT market. [4] In this paper, aiming a provide a flexible and completed solution for building a private LoRa network, the design and implementation of the LoRa network have been proposed including hardware and software. Moreover, the open-source project is available on GitHub. [1]

The project implementation includes building a hardware model and a mobile app to properly operate the model. So before working we need to be considering the following technologies and methods that we will be using during the implementation

LoRa:
LoRa (short for long range) is a spread spectrum modulation technique derived from chirp spread spectrum (CSS) technology. Semtech's LoRa is a long-range, low-power wireless platform. LoRa devices and networks such as the Lora WAN enable smart IoT applications that solve some of the biggest challenges facing our planet: energy management, natural resource reduction, pollution control, infrastructure efficiency, and disaster prevention. Semtech's LoRa devices have amassed several hundred known uses cases for smart cities, homes and buildings, communities, metering, supply chain, logistics, agriculture, and more. [8]

For the project we will be using the LoRa 868MHZ SX1276 RF trans-receiver module which will be used to access LoRa devices in the network and these devices will be getting all data and other instructions from the ATmega328p chip. This trans receiver module will receive and transmit the messages and route them down to the microcontroller.

GPS:
The Global Positioning System (GPS) is used to find longitude and latitude parameters in form of NMEA sentences from satellites with the parameters like current date and time. So, we are capturing that using our devices in bult GPS receiver and using it so can be sent with the data packets so users can get the location (with sender's permission) of the user who is sending massage or might be asking for help.[9]

MAIN HIGHLIGHTS OF BITSTREAM:

- **Long Range:** Connects devices up to 30 miles apart in rural areas and penetrates dense urban or deep indoor environments
- **Low Power:** Requires minimal energy, with a prolonged battery lifetime of up to 10 years, minimizing battery replacement costs
- **Secure:** Features end-to-end AES128 encryption, mutual authentication, integrity protection, and confidentiality
- **Standardized:** Offers device interoperability and global availability of Lora WAN networks for speedy deployment of IoT applications anywhere
- **Geolocation:** Enables GPS-free tracking applications, offering unique low power benefits untouched by other technologies
- **Mobility:** Maintains communication with devices in motion without strain on power consumption

Reduces infrastructure investment, battery replacement expense, and ultimately operating expenses Both Sigfox and LoRa use simple radio designs which use less silicon and therefore cost less to make. These designs deliver signals over very long distances, eliminating the need for cell-type technology as signals can be picked up from a few gateways scattered around a city (this is referred to as a star topology)., this could – in the end – limit the number of connections and data in the network. [2]

IV. EXPECTED OUTCOMES

Fig. 3(B): Bitstream product model

HOW TO USE IT?

You need to follow the following steps to use the device with mobile:

- Install and open application on your mobile device
- Connect the device through a USB cable
- Register with mobile number and fill personal details in mobile app
- Then you will see the interface as below Fig. now you are ready to use your device.

Fig. 04(A): Transmitter side mobile interface

- After you connected to the device properly and opened the mobile app you will be seeing interface in Fig.04(A)
- Then the user needs to enter the message that he wants to send in the blank field.
- And enter send button then the massage will be sent with the current location of the device and printed on the same screen. [2]
- User can also click on the SOS button on the hardware to send a message this will send the prebuild massage on the device.
- As another receiver receives the massage acknowledgment will be sent and printed on the same screen.
- Each sent message will carry its metadata such as transmitters ID, receivers ID, GPS location, message ID, etc.

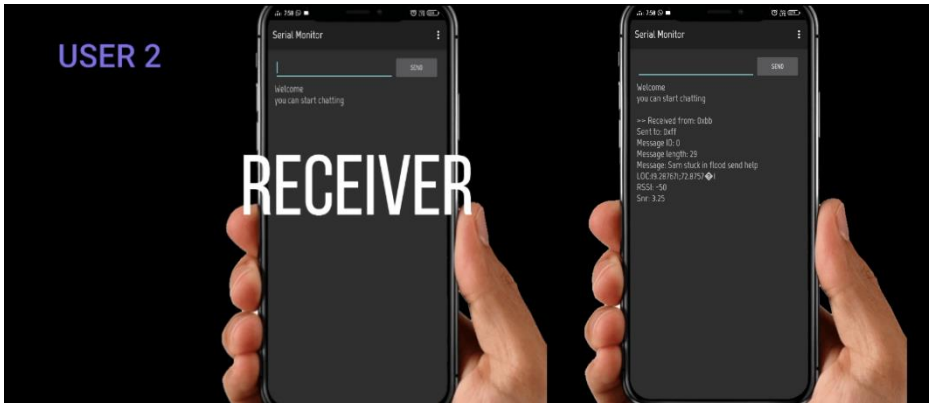


Fig. 03(B): Receiver side mobile interface

At receiver side massage sent are printed after they are received, and acknowledgment will Also, send to the transmitter.

TEST Results:

Optimum Battery Life	3 weeks
RSSI	70 - 120 dBm
Range	0.5 Km
SNR	-20 dB and +10

During testing of the prototype, we observed the following reading from the device and the conditions for the testing are not completely ideal so the results may vary

The market growth in this segment is attributed to the growing demand for satellite capacity that has led to the rise of Internet-based applications associated with wired and wireless cellular communications technologies.

V. CONCLUSION

Based on the research and the tests on the prototype we came to some conclusions which are discussed below these points gives insights on where the next iterations of the project can be improved:

Use of High gain antenna:

Currently, we have used a 2cm spiral antenna for the prototype which does not gives much gain so that reduces the receiver's range.

Make a compact product:

Reducing the size of the product and using it as a wearable product can significantly increase the usability of the product in the situations where it is meant to be used. [3]

Dense network:

To cover the large area relay devices can be used that will retransmit the message to another receiver in its range.

Due to disasters, the area affected by it gets cut off from the communication system there is a high requirement of communication for rescue, emergency medical attention, proper deployment of emergency services, etc. these kinds of services are very important for that area but because of down communication system these services can't be provided which has a large consequence on community life and property the emergency communication system can be very helpful to provide the essential things to the victims.

The graph shows how efficient the proposed emergency communication system will be in providing food and essential things and saving lives during Disasters. The people and the emergency response team and different emergency services will be able to be in contact with the victims and the people who need urgent help from the first responders.

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